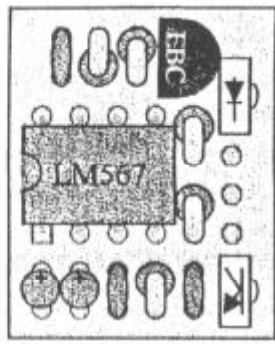
Modulated infrared reflective detector

Detect objects without physical contact!

Mondo-tronics

This kit detects objects by means of a modulated infrared beam.
Its open collector output can sink 100mA for direct drive of an indicator or relay.
It is ideal as a proximity detector on miniature robots. Use it wherever you require no-contact detection at short distances with high noise immunity.

- *Tiny* - just 18 x 21 x 9 mm thick (0.75 x 0.88 x 0.38 inch)
- *Light* - weighs less than 3.4 grams.
- *Strong* – open collector output sinks up to 100mA.
- *Logical* – uses standard 5V supply & OC output.
- *Sensitive* – detects objects up to several inches away.
- *High Noise Immunity* – modulated signal reduces response to ambient infrared noise.



Easily assembles in under an hour. Electronics experience is helpful but not required. You will need: soldering iron for electronics, solder, side cutter and objects to detect- a cat, for instance...

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We fully guarantee the quality and completeness of this kit.

If you suspect aught be gang agley, get in touch! You'll get attention!

Made in the USA exclusively for Mondo-tronics by TFX, 1961 Taggart Way, Galt's Gulch, Co.

Consciousness is identification.

Rev. 1.1

1 - How it Works

A matched infrared emitter / detector pair is used for optical detection in this circuit. The emitter LED is pulsed by the voltage controlled oscillator section of a LM567 tone decoder IC.

The center frequency (f_c) of the oscillator is set by the combination of R_1 & C_1 according to the formula: $fc = 1 / (1.1 \times R_1 \times C_1)$.

{ f_c =KHz R=KΩ C=uF $2K \le R \le 20K$ }

For the components supplied with this kit, the $f_c \approx 909$ Hz.

The matched detector, in response to the reflection of the emitter from an object, generates a signal for the tone decoder. Capacitative coupling of this signal allows for better detection under variable conditions of ambient brightness.

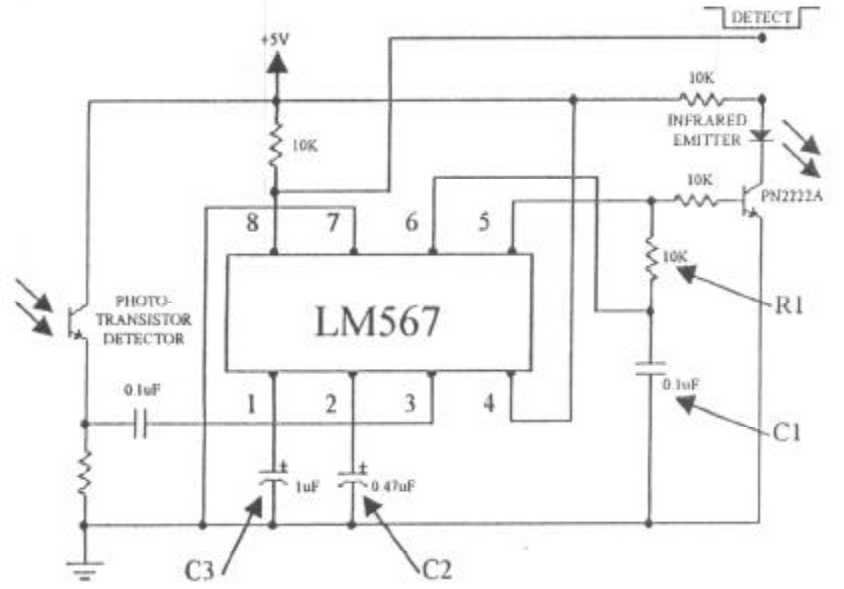
The tone decoder compares the input frequency to the f_c of its VCO. If the frequency is close enough to f_c, the IC sends pin 8 LOW. (A 10K resistor holds it high, otherwise.) This is an open collector output capable of sinking up to 100 mA.

What's close enough to f_c for a lock? Bandwidth is determined by C_2 according to the formula: $BW = 1070 * \sqrt{V / (f_c \times C_2)}$.

{ f_c=Hz V=input VRMS V≤200mV C=uF BW=% f_c }

Maximum BW is about 14% of f_c. Increasing C_2 narrows the bandwidth. C_2 should be at least 2 x C_1. With this circuit, bandwidth for detection may not be an issue as this circuit detects its own f_c!

C_3 is the output filter. It should be at least 2 * C_2. Its function is to reduce output chatter as the decoder goes in & out of lock.



Please make use of the table below to hack the frequency and bandwidth.

R1 KOhm	C1 uF	C2 uF	F lower KHz	F center KHz	F upper KHz	BW % Fc
2.2	0.1	0.47	3.974	4.132	4.291	7.7
2.4	0.1	0.47	3.636	3.788	3.940	8.0
2.7	0.1	0.47	3.224	3.367	3.510	8.5
3.0	0.1	0.47	2.894	3.030	3.166	9.0
3.3	0.1	0.47	2.625	2.755	2.884	9.4
3.6	0.1	0.47	2.401	2.525	2.649	9.8
3.9	0.1	0.47	2.212	2.331	2.450	10.2
4.3	0.1	0.47	2.001	2.114	2.228	10.7
4.7	0.1	0.47	1.826	1.934	2.043	11.2
5.1	0.1	0.47	1.678	1.783	1.887	11.7
5.6	0.1	0.47	1.524	1.623	1.723	12.2
6.2	0.1	0.47	1.372	1.466	1.561	12.9
6.8	0.1	0.47	1.266	1.377	1.469	13.3
7.5	0.1	0.47	1.127	1.212	1.297	14.0
8.2	0.1	0.47	1.031	1.109	1.166	14.0
9.1	0.1	0.47	0.929	0.999	1.069	14.0
10.0	0.1	0.47	0.845	0.909	0.973	14.0
11.0	0.1	0.47	0.769	0.826	0.884	14.0
12.0	0.1	0.47	0.705	0.758	0.811	14.0
13.0	0.1	0.47	0.650	0.699	0.748	14.0
15.0	0.1	0.47	0.564	0.606	0.648	14.0
16.0	0.1	0.47	0.528	0.568	0.608	14.0
18.0	0.1	0.47	0.470	0.505	0.540	14.0

R1 Kohm	C1 uF	C2 uF	F lower KHz	F center KHz	F upper KHz	BW % Fc
2.2	0.1	1.0	4.023	4.132	4.241	5.3
2.4	0.1	1.0	3.684	3.788	3.892	5.5
2.7	0.1	1.0	3.269	3.367	3.465	5.8
3.0	0.1	1.0	2.937	3.030	3.123	6.1
3.3	0.1	1.0	2.666	2.755	2.844	6.4
3.6	0.1	1.0	2.440	2.525	2.610	6.7
3.9	0.1	1.0	2.249	2.331	2.413	7.0
4.3	0.1	1.0	2.036	2.114	2.192	7.4
4.7	0.1	1.0	1.860	1.934	2.009	7.7
5.1	0.1	1.0	1.711	1.783	1.854	8.0
5.6	0.1	1.0	1.555	1.623	1.692	8.4
6.2	0.1	1.0	1.401	1.466	1.531	8.8
6.8	0.1	1.0	1.315	1.377	1.440	9.1
7.5	0.1	1.0	1.153	1.212	1.271	9.7
8.2	0.1	1.0	1.052	1.109	1.165	10.2
9.1	0.1	1.0	0.946	0.999	1.052	10.7
10.0	0.1	1.0	0.858	0.909	0.960	11.2
11.0	0.1	1.0	0.778	0.826	0.875	11.8
12.0	0.1	1.0	0.711	0.758	0.804	12.3
13.0	0.1	1.0	0.655	0.699	0.744	12.8
15.0	0.1	1.0	0.564	0.606	0.648	13.7
16.0	0.1	1.0	0.528	0.568	0.608	14.0
18.0	0.1	1.0	0.470	0.505	0.540	14.0

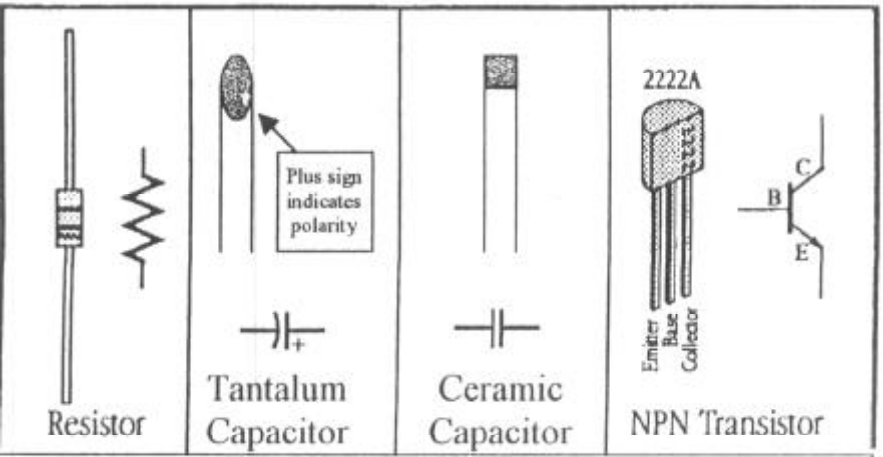
2 – Parts

As you assemble the circuit board, refer to the list below and to the instructions. Check your kit of parts with this list.

Unit	Description
1 pc.	Infrared emitter (black top)
1 pc.	Infrared phototransistor (red top)
1 pc.	Transistor, NPN type, PN2222A
1 pc.	Resistor, 100 ohm ¼ W (brn, blk, brn, gold)
4 pc.	Resistor, 10K ¼ W (brn, blk, orng, gold)
3 pcs.	0.1 uF Ceramic capacitor
1 pc.	0.47 uF Tantalum capacitor
1 pc.	1.0 uF Tantalum capacitor
1 pc.	PC Board, TFX IRD 1.0
1 pc. *	Header, 7 pin, 0. 1" spacing
1 pc.	Instructions (these)

*Indicates optional part. Use as required in your application.

The drawings below show the parts and their schematic symbols.



In addition, you will need a microtip soldering iron for electronics, solder, side-cutter, 5-volt power source and objects to detect.
Electronics experience is helpful but not required. If you have never assembled electronics before, please see section 5 first.

3 - Assembly & Parts Placement

Hold it! Do not install the infrared emitter and detector until after you have read section 4!

1) Begin by inserting the Tantalum capacitors in their respective locations. They are very easy to confuse, so it is best to get past this bit first. Be careful to observe the polarity of these parts!

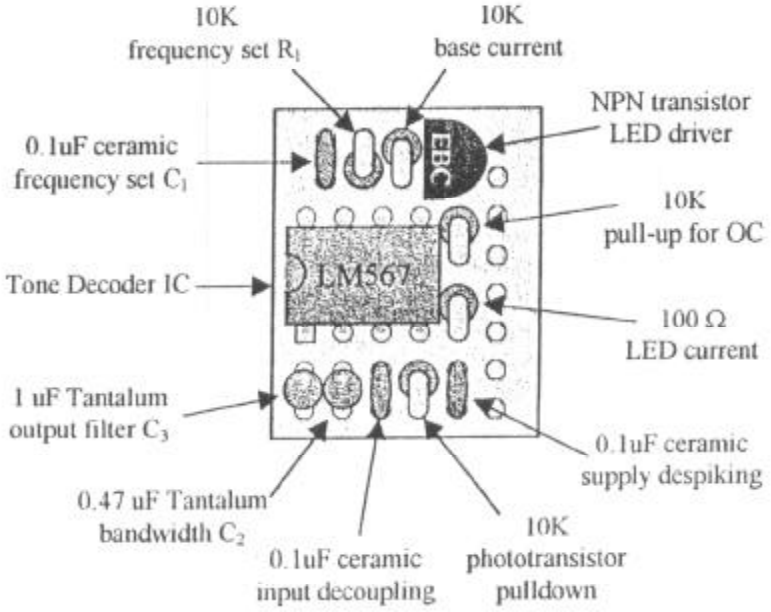
2) Next, bend one lead of each resistor (either end will do), as shown.

3) Insert one part into its marked location on the board. Observe that it is correct for its location and that it is oriented correctly. Never "orientate" anything; use proper grammar.

4) Double check the part's location and orientation before proceeding with soldering.

5) Carefully solder the leads of the part. (If you have never assembled electronics before, read section 5 first!) When the solder has cooled, clip the lead close to the board.

6) Repeat for all parts.



4 - Connections & Testing

- *Are all parts installed in correct location and orientation? If not, carefully unsolder, clean the holes, and replace properly.*
- *Are all leads trimmed, with clean solder joints, no excess solder, short-circuits, or cold joints? If not, trim, resolder or clean as necessary.*

This is your last chance to make corrections before applying power. Damage to components is a likely result of deficiency at this stage. Be good to yourself and take out the insurance now.

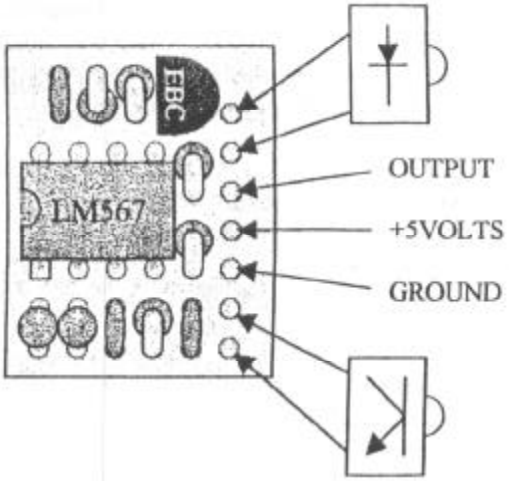
The infrared emitter and the phototransistor may be soldered to the board or connected to it by twisted wires up to a foot long.

Something we can't see with our own eyes is that the entire case of the emitter glows when it transmits! Furthermore, the case of the phototransistor can pick up enough light through the sides or top to cause a lock! It is therefore necessary to insulate carefully against unwanted signal!

A nice sensor can be made by wrapping the emitter and detector individually in aluminum foil (shiny side in). Then super-glue them together. Cut away any foil that might contact the leads and any which overhangs the top. Use a bit of black paint on the bottom end (from which the leads protrude) to make sure it is completely blacked out. Make a mark to identify emitter and detector, then sand the top until the clear cases show. Buff lightly on your pant leg. Connect this sensor to the PC board with twisted wires. It will lock on objects from ¼ to 1 inch away, depending on the infrared reflectivity, using only the light transmitted through the tops of the cases!

Once you've decided how to mount your emitter/detector pair, it's time to wire it in, connect power and observe its performance. Use a logic probe, meter or LED to monitor the output.

Mount a small piece o' paper (such as from a hole puncher) on a thin stick. Move it towards the detector until it is detected.
At the same distance from the detector, move the paper in ever widening circles to determine the detection window.
The window varies with distance, too. Try to map out the three-dimensional detection corridor. This information will help you get the best performance in your application.



You can **adjust the sensitivity** of the detector by merely creating an aperture for the detector and adjusting it. (Let the emitter be loud). A piece of black tape or a careful application of a bit of black paint can restrict the amount of signal reaching the detector to get the desired sensitivity.

You can **adjust the detection corridor** by merely creating an aperture for the emitter and adjusting it.

Have fun with your new toy!

EVERYTHING IS CORRECTLY ASSEMBLED BUT THE CURSED THING ISN'T WORKING:

If the output is always LOW, it's very likely there is a light leak. You can confirm this by disconnecting the emitter. With the emitter disconnected, the output should be HIGH. If this is the case, then you must do something more to black out the emitter so it can put light only into the detection corridor and black out the detector so that only reflections from an object in the detection corridor can reach it. The matched pair is quite sensitive.

If this is not the problem, double check your component placement, orientation and polarity; double-check the soldering. If you find the problem here, you must correct it and hope no part was damaged!

Otherwise, get in touch.

5 - Assembling Electronics

If you have never assembled electronics you should read about the basics before you begin. The steps below outline the basic procedures for preparing, soldering and inspecting many kinds of electronic components. With a few tools and a little patience you will have no trouble assembling, testing and using your kit.

F5.1 - Basic tools needed:
Soldering iron, small sponge, electronic solder, needle nose pliers, side cutters. Optional: Spare soldering iron tip, solder wick, flux remover.
Plug in the iron, and moisten the sponge with water. When the iron is hot, "tin" the tip with a small amount of solder. (Replace the tip if it is corroded).
Wipe the tip across the damp sponge frequently to keep it clean. A clean, well-tinned tip does best. Spoil yourself.

F5.2 - Bend the component leads to fit the holes on the board.

F5.3 - Insert the component, observing any special orientation it may require. Bend the leads enough to hold the part flush against the board, but do not overbend.

F5.4 - Wipe the tip clean and tin it with a small amount of solder.

F5.5 - Heat the joint by placing the soldering iron's tip against both the component lead and the circuit board pad.

F5.6 - After a moment of heating, touch the solder to the lead & pad only. (If touched to the iron it will blob up.) When the solder flows, remove it and hold the tip in place for one second. Remove the iron without moving the part and let the joint cool.

F5.7 - Trim excess component lead with the side cutter. Parts with short leads do not need to be trimmed. Inspect the joint. A good solder joint blends the lead and pad smoothly together and has a smooth, bright finish.